Variables Predicting Adverse Outcome in Patients With Deep Sternal Wound Infection

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Background. **Mortality after deep sternal wound infection (DSWI) ranges between 5% and 47%. Variables predicting hospital mortality and prolonged hospital stay are still to be assessed.**

Methods. **Among 13,420 patients who underwent cardiac surgery in our institution between 1979 and 1999, DSWI developed in 112 cases (0.8%). Multiple variables were recorded prospectively and analyzed retrospectively as predictors of hospital death and prolonged (>30 days) hospital stay. The analyzed variables were divided into three groups: (1) related to the patient, including demographic variables and preoperative conditions; (2) related to cardiac operation; and (3) related to infection. Predictive variables were assessed by univariate and multivariate logistic regression analysis.**

Results. **Hospital mortality was 16.9%. The hospital stay of the 93 discharged patients ranged between 16 and 180 days (mean 31.3 ± 15.2). Length of cardiac operation, length of stay in intensive care unit, interval between symptoms of DSWI and wound debridement were found to be the most significant predictors of bad outcome following DSWI.**

Conclusions. **In our study demographic variables and preoperative conditions did not affect the prognosis of DSWI. Lower mortality rate and shorter hospital stay could be achieved with earlier and aggressive treatment of DSWI.**

(Ann Thorac Surg 2001;71:324–31)

Deep sternal wound infection (DSWI), or mediastinitis, is a serious and life-threatening complication after open heart surgery; despite appropriate antibiotic treatment and wound debridement, infection can propagate within the mediastinum and involve the cardiac suture lines leading to septic shock or catastrophic hemorrhage [1, 2].

The incidence of postcardiotomy mediastinal infections ranges between 0.15% [3] and 8% [4] and is approximately 1% to 2% in the most recently reported series [5–10]. Many studies [2–12] have identified risk factors for development of postoperative DSWI: many of the analyzed variables are patient-related; others are related to the surgical procedure or to postoperative clinical course. Unfortunately, only a few of these risk factors are modifiable [13]. Moreover, because of modern progresses in cardiac surgery, an increasing number of elderly and immunodepressed patients with multiple risk factors are treated surgically for cardiac diseases. Therefore, in spite of accurate hospital infection control, improved antibiotic therapy, and perioperative asepsis, the incidence of poststernotomy DSWI has remained constant over the years [4, 13].

The prognosis of DSWI is serious; despite early wound debridement, mediastinal irrigation with antiseptic or antibiotic solutions, plastic reconstruction with muscle or omental flaps, intravenous antibiotic therapy, mortality for DSWI is still high, ranging between 5% and 47% [5, 6, 10, 14]. Moreover, intensive care unit and hospital stay are significantly prolonged in patients who acquire postoperative DSWI [8, 10].

The outcome of sternal infections is often unpredictable: many patients, in spite of a slightly protracted hospital stay, achieve complete wound healing; on the contrary in other patients multiple procedures such as repetitive wound debridement, open wound dressing, plastic reconstruction procedures, local and systemic antibiotic therapy result unsuccessful, ending in hospital mortality or leading to very prolonged hospital stay with extreme distress for the patient and waste of financial resources [1, 15].

Although many authors have already investigated risk factors for development of DSWI, no studies have been performed in order to find out which variables can affect the course and outcome of DSWI. Moreover, the impact of demographic variables, preoperative conditions, and type of cardiac operation on DSWI patients' survival has not been fully assessed yet. The purpose of the present study was to review our experience in the treatment of DSWI over a 20-year period and to assess the variables predicting hospital mortality and prolonged hospital stay.

Patients and Methods

Between January 1979 and January 1999, 13,420 patients underwent open heart surgery through a complete me-

Accepted for publication May 10, 2000.

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Published by Elsevier Science Inc

0003-4975/01/$20.00
PII S0003-4975(00)02137-8

dian sternotomy at our institution: the perioperative protocol of infection control remained almost unchanged over the years.

Elective patients were showered and shaved the day of their operation. In all cases, since the morning of the operation, patients received intravenous cephalosporins and intramuscolar aminoglycosides, until central line and drains were removed.

The operative field was painted with povidone-iodine solution and the skin was covered with an adhesive plastic sheet. The skin was incised with a scalpel and electrocautery was used to open the presternal layers and the pericardium. Bone wax was used only when sternal bleeding was profuse. Internal mammary arteries (IMA), when used for coronary bypass, were harvested as pedicled in situ grafts. A chest tube was placed whenever the pleural cavity was opened. The sternum was closed with stainless steel wires. The presternal space was obliterated with two layers of adsorbable suture, and the skin was closed with a subcuticular adsorbable suture. Chest tubes were connected to 15 cm of water suction postoperatively. Patients were extubated when they were hemodynamically stable, normothermic, and ventilating spontaneously. All drains were removed on the second postoperative day or when drainage was lower than 25 mL/h. Wound dressing was removed on the second postoperative day and redressed only once. Further dressing was performed only if there was wound discharge.

Management of Infection

All patients operated on at our institution were seen at 1 week, 1 month, and 6 months postoperatively in the outpatient department. Clinical status of patients breaking an appointment was assessed by phone interviews. Additional outpatient visits were prescribed when needed. Deep sternal wound infection (defined according to the guidelines of the Center for Disease Control and Prevention [16] was observed in 112 cases (0.8%). Diagnosis of DSWI required at least one of the following criteria: (1) an organism was isolated from culture of mediastinal tissue or fluid; (2) evidence of mediastinitis was seen during operation; or (3) one of the following: chest pain, sternal instability, or fever (> 38°C), was present and there was either purulent discharge from the mediastinum or an organism isolated from blood culture or culture of drainage of the mediastinal area.

As far as the demographic variables of the patients are concerned, 82 were male (73.2%) and 30 were female (26.8%) with an age ranging between 18 and 75 years (mean 58.13 ± 9.8). Nineteen patients required hospital readmission when the diagnosis of DSWI was made during their follow-up period.

As soon as the clinical diagnosis of suspected wound infection was made, swabs for culture were taken from wound secretion and sent for microbiology and patients were started on broad-spectrum antibiotic therapy.

Our policy in the treatment of mediastinitis can be divided into two periods. Until January 1995 a trial of conservative treatment was made: systemic and local antibiotic therapy together with povidone-iodine dressing was performed in all cases and the indications for surgical debridement were delayed until wound dehiscence, sternal instability, and signs of systemic infection were grossly evident. In January 1995 we changed our policy: all patients with wound discharge and even minimal sternal instability underwent wound debridement and mediastinal irrigation with povidone-iodine solution on emergency basis. Patients were taken to the operating room and wound reopening was performed. All sternal wires and fascial or subcutaneous sutures were removed, samples of mediastinal fluids were taken for culture, the pericardial sac was washed with antibiotic and povidone-iodine solutions. A drain for mediastinal irrigation and two tubes for drainage, one in the pericardium and one in the anterior mediastinum, were placed. If a pleural space was open, an additional drain was positioned just above the diaphragm. Sternal and wound debridement were performed. The sternum was not approximated. Skin and subcutaneous layers were full-thickness closed with non-absorbable interrupted stitches. Mediastinal irrigation was performed alternating every 6 hours at 100 mL/h of 5% povidone-iodine saline solution and 100 mL/h of saline solution with antibiotics according to in vitro sensitivity. Intravenous antibiotic therapy according to the results of microbiology tests was continued all during mediastinal irrigation. On the seventh postoperative day the infusion was stopped, and swabs for culture were taken from the drains. If cultures were sterile, wound healing was satisfactory, fever and leukocytosis disappeared, then the drains were removed and the patient was discharged. If wound drainage or bacterial growth from cultures were observed, mediastinal irrigation was restarted and carried on another 7 days, and then drains were removed. When the infection recurred in spite of mediastinal irrigation, several alternative treatments were performed: secondary wound debridement and mediastinal irrigation for 7 days in 15 cases, open wound dressing with granulated sugar alone in 9 cases, open wound dressing with granulated sugar and hyperbaric therapy in 8, and plastic reconstruction with pectoralis flaps in 6 cases.

Definitions

Multiple variables were recorded prospectively and analyzed retrospectively as predictors of hospital death and prolonged (> 30 days) hospital stay. Hospital death was defined as death occurring during the hospital stay or within 30 days from the last surgical procedure. Comparisons of baseline demographics and preoperative, intraoperative, and postoperative variables were made between patients who died during their hospital stay and patients who were discharged. Further comparisons were performed between patients discharged before versus after postoperative day 30. Patients who died during their hospital stay were excluded from the analysis of length of hospital stay. Variables and their definitions are listed in Table 1.

Table 1. Variables Assessed in Predictive Models

Related to patient
- Age
- Sex
- Obesity: body mass index (weight in kg divided by square of height in m^2) > 30
- Smoking (history of smoke habit, > 20 cigarettes/day)
- Diabetes mellitus (fasting blood glucose > 140 mg/dL in at least two assays or use of antidiabetic medication)
- Albumin disorders: serum albumin levels < 4.5 g/dL
- Chronic renal failure (serum creatinine > 1.8 mg/dL)
- Ejection fraction: left ventricular ejection fraction measured either by cineangiography or by B-mode echocardiography

Related to cardiac operation
- Operative time (hours)
- Procedure: kind of operative procedure (coronary artery bypass grafting, valve replacement; aortic replacement for aortic dissection, reoperation, heart transplant, others)
- Type of CABG procedure (only vein, left internal mammary artery [IMA] plus vein, left IMA plus right IMA plus vein)
- Emergency surgery (operation within 6 hours of admission)
- Opened pleural cavity
- Cross-clamp time (minute)
- Intraaortic balloon pumping insertion
- Intubation time
- Length of stay in intensive care unit
- Bleeding: amount of blood losses in the first postoperative 24 hours (mL)
- Transfusion: need of blood transfusion
- Reoperation for bleeding;

Related to infection
- Interval symptoms–wound debridement: interval between onset of symptoms of the infection (fever or sternal wound purulent discharge) and wound debridement (days)
- Positive bacteriologic data (bacterial growth at cultures of swabs from mediastinal fluid
- Mycrobiologic data: cultures results (negative culture, Gram positive, Gram negative, Gram positive and Gram negative)
- Leukocytosis: persistence of leukocytosis (WBC > 11.000/μL) after wound debridement
- Fever: persistence of fever (body temperature > 37.5°C) after wound debridement

Statistical Analysis

Univariate categorical data were analyzed through contingency table methods. Continuous variables were divided into quartiles for contingency table analysis, and were also analyzed as continuous variables by univariate logistic regression. The p values were computed using χ^2 statistics for contingency tables, and odds ratios were test based. Multivariate analysis was conducted by multiple logistic regression. The p values for logistic regression analyses were computed by maximum-likelihood methods. All analyses were performed using the SPSS software version 8.0 (SPSS, Inc, Chicago, IL).

Limitation of the Study

Although our diagnostic criteria and treatment protocols have mostly remained unchanged over the years, this study reviews a 20-year experience; therefore, modifications in diagnostic and surgical techniques can have added some bias to our results.

Results

Nineteen patients (16.9%) died during their hospital stay. Causes of death included sepsis in 8 cases, respiratory failure in 4, multiorgan failure in 4, massive bleeding from the aortic cannulation site in 1 and from right ventricular tear in 1, and cardiac failure in 1.

Wound healing was observed in 93 cases. Hospital stay ranged between 16 and 180 days (mean 31.3 ± 15.2). Germs isolated from wound secretions or from mediastinal fluid are reported in Table 2.

Follow-up time ranged between 6 months and 20 years (mean 167 ± 13 months). Nineteen cases of late mortality have been observed: 14 cases because of cardiac causes (cardiac failure in 6, prosthetic thrombosis in 2, myocardial infarction in 6) and 5 because of extracardiac causes (2 cases for cancer, 2 for chronic renal failure, 1 for stroke).

Univariate analysis (Table 3) showed that length of cardiac operation more than 6 hours, cardiac transplant, blood losses in the early 24 postoperative hours more than 1,000 mL, length of postoperative intubation less than 24 hours, length of stay in intensive care unit (ICU) more than 96 hours, interval between onset of symptoms and wound debridement more than 20 days, positive wound cultures, positivity of cultures for both Gram-positive and Gram-negative species, culture positivity for *Staphylococcus aureus*, persistence of fever, and leukocytosis after wound debridement were associated with a significantly higher hospital mortality for DSWI.

Multivariate statistical analysis (Table 4) showed that length of stay in ICU more than 96 hours, postoperative bleeding more than 1,000 mL, positive cultures from the wound, and prolonged time between the initial symptoms and wound debridement were determinants of hospital death following mediastinal infection.

At univariate analysis (Table 5) age over 58 years, length of cardiac operation, length of stay in ICU, length

Table 2. Bacterial Species Isolated From Wound Secretions or From Mediastinal Fluid

Bacterial Species	Number (%)
Gram positive	44 (77.2)
Staphylococcus aureus	28 (49.1)
Staphylococcus epidermidis	16 (28.1)
Gram negative	13 (22.8)
Pseudomonas aeruginosa	10 (17.55)
Serratia marcescens	1 (1.75)
Enterobacter cloacae	1 (1.75)
Proteus mirabilis	1 (1.75)

Table 3. Variables Studied as Univariate Predictors of Death in Patients With Deep Sternal Wound Infection

Variables	Categories	No. of Patients (%)	Mortality (%)	p^a
Age (years)	< 50	28 (25)	4 (14.3)	0.89
	50.1–54	28 (25)	5 (17.9)	
	54.1–58	28 (25)	4 (14.3)	
	> 58	28 (25)	6 (21.4)	
Sex	Male	82 (73.2)	14 (17.1)	0.32
	Female	30 (26.8)	5 (16.7)	
Obesity	Yes	32 (28.6)	8 (25)	0.81
	No	80 (71.4)	11 (13.75)	
Smoking	Yes	74 (66.1)	13 (17.6)	0.78
	No	38 (33.9)	6 (15.8)	
Diabetes	Yes	65 (58)	13 (20)	0.25
	No	47 (42)	6 (12.8)	
Albumin disorder	Yes	89 (79.5)	15 (16.8)	0.77
	No	23 (20.5)	4 (17.4)	
Chronic renal failure	Yes	43 (38.4)	6 (13.9)	0.48
	No	69 (61.6)	13 (18.8)	
Ejection fraction (%)	< 40	17 (15.2)	5 (29.4)	0.58
	> 40	95 (84.8)	14 (14.7)	
Operative time (h)	< 4	63 (56.25)	8 (12.7)	0.002
	4–6	42 (37.5)	6 (14.3)	
	> 6	7 (6.25)	5 (71.4)	
Procedure	CABG	56 (50)	7 (12.5)	0.001
	VR	34 (30.4)	5 (14.7)	
	Ao. Diss.	8 (7.1)	3 (37.5)	
	Reoperation	7 (6.25)	1 (14.3)	
	Transplant	4 (3.6)	2 (50)	
	Other	3 (2.65)	1 (33.3)	
Type of CABG	No	56 (50)	12 (21.4)	0.09
	Only vein	19 (17)	2 (10.5)	
	Left IMA+vein	32 (28.6)	5 (15.6)	
	Left IMA+right IMA+vein	5 (4.4)	0	
Emergency surgery	Yes	20 (17.9)	6 (30)	0.24
	No	92 (82.1)	13 (14.1)	
Opened pleural space	Yes	55 (49.1)	10 (18.2)	0.54
	No	57 (50.9)	9 (15.8)	
Cross-clamp time (min)	< 40	28 (25)	5 (17.8)	0.12
	40–60	60 (53.6)	8 (13.3)	
	> 60	24 (21.4)	6 (25)	
IABP	Yes	8 (7.1)	3 (37.5)	0.15
	No	104 (92.9)	16 (15.4)	
Length of intubation	< 24h	25 (22.3)	10 (40)	0.001
	> 24h	87 (77.7)	9 (10.3)	
Length of stay in ICU	< 48h	2 (1.8)	0	
	48–96h	91 (81.25)	11 (12.1)	
	> 96h	19 (16.95)	8 (42.1)	0.016
Bleeding (mL)	< 600	48 (42.9)	9 (18.75)	
	600–1,000	57 (50.9)	5 (8.8)	
	> 1,000	7 (18.2)	5 (71.4)	0.0001
Transfusion	Yes	64 (57.1)	15 (23.4)	0.05
	No	48 (42.9)	4 (8.3)	
Reoperation for bleeding	Yes	25 (22.3)	2 (8)	0.11
	No	87 (77.7)	17 (19.5)	
Interval symptoms–WD (days)	< 20	91 (81.25)	2 (2.2)	
	> 20	21 (18.75)	17 (81)	0.0001

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Table 3. Variables Studied as Univariate Predictors of Death in Patients With Deep Sternal Wound Infection (Continued)

Variables	Categories	No. of Patients (%)	Mortality (%)	p^a
Positive bacteriologic data	Yes	54 (48.2)	16 (29.6)	0.006
	No	58 (51.8)	3 (5.2)	
Microbiologic data	Negative	58 (51.8)	4 (6.9)	0.0006
	Gram+	41 (36.6)	12 (29.3)	
	Gram−	10 (8.9)	1 (10)	
	G+ and G−	3 (2.7)	2 (66.7)	
Staphylococcus aureus	Yes	28 (25)	12 (42.9)	0.02
	No	84 (75)	7 (8.3)	
Pseudomonas aeruginosa	Yes	10 (8.9)	3 (33.3)	0.34
	No	102 (91.1)	16 (15.7)	
Fever	Yes	49 (43.75)	19 (38.8)	0.001
	No	63 (56.25)	0	
Leukocytosis	Yes	66 (58.9)	17 (25.7)	0.002
	No	46 (41.1)	2 (4.3)	

[a] Significant at $p < 0.05$.

CABG = coronary artery bypass grafting; VR = valve replacement; Ao. Diss. = aortic replacement for aortic dissection; IMA = internal mammary artery; IABP = intraaortic balloon pumping insertion; ICU = intensive care unit; WD = wound debridement.

of the interval from symptoms to wound debridement, and persistence of leukocytosis were found to be determinants of prolonged hospital stay in patients with DSWI. In multivariate analysis (Table 6) long operative time and delayed wound debridement were found to be associated with significantly longer hospital stay.

Comment

Mediastinal infection is a dreadful complication of open-heart surgery. Simple medical treatment is often ineffective; infection may cause septicemia or propagate to the cardiac sutures leading to massive hemorrhage [1, 2]. Reoperation is mandatory; nevertheless infection may continue, leading to local and systemic complications. Treatment is distressing for both the patient and the surgeon, because the rate of failure is high and the dressing may be painful and time consuming. Hospitalization time is considerably prolonged and a large amount of resources is wasted [5, 6, 8, 10].

Many studies [2–13] have been performed to find out the risk factors for development of postoperative mediastinitis to lessen the incidence of such complications. Many factors have been found to increase the incidence of postoperative sternal infections. Some authors [9, 17] classified risk factors as preoperative, intraoperative, and postoperative factors. Although those risk factors have been well identified as causes of DSWI, unfortunately only few of these are modifiable [13]. Moreover, almost all patients undergoing cardiac surgery in the 1990s had at least two risk factors for developing postoperative DSWI.

Table 4. Multiple Logistic Regression Model: Variables Predicting Hospital Death

Variable	Goodness of Fit	Adjusted Odds Ratio	p Value
Length of stay in ICU > 96 hours	2.312	7.578	0.007
Bleeding > 1,000 mL/24 hours	1.871	15.6	0.003
Interval symptoms-WD > 20 days	8.154	35.56	0.0001
Positive bacteriologic data	1.766	12.3	0.002

ICU = intensive care unit; WD = wound debridement.

The appropriate treatment of DSWI is still a matter of controversy: since Shumaker and Mandelbaum [18] proposed closed chest catheter irrigation, this has been the treatment of choice for DSWI, but in the recent years plastic procedures either with omental or pectoralis muscle flaps have reported to have a high rate of success and short hospital stay [17, 19, 20, 21]. Open wound dressing is no longer employed as the primary treatment of DSWI, having a high rate of morbidity and unacceptably longer hospital stay [24].

Mortality after DSWI is still high, ranging between 5% and 47% in spite of early diagnosis and appropriate treatment [5, 6, 10, 14, 17]. Although some authors [19] reported no hospital mortality in small series including patients with sterile sternal dehiscence and with DSWI undergoing either closed chest irrigation and pectoral muscle flap, mortality for DSWI is still high. The Duke's series of patients who underwent CABG [21] reports an 8.1% mortality rate in patients with DSWI. Mortality rates in large series reported in the last decade range between 4.8% and 10.8% both in patients undergoing plastic procedures and in those treated with closed chest irrigation [20, 22, 23]; therefore neither plastic procedures nor closed chest irrigation has proved in large series to reduce the mortality rate for DSWI below 4%.

Our series reports a mortality of 16.9% over 20 years, including patients who had undergone cardiac transplant and those operated upon during deep hypothermia and circulatory arrest for type A aortic dissection. Moreover,

Table 5. Variables Studied as Univariate Predictors of Prolonged Hospital Stay in Surviving Patients

Variable	Categories	No. of Patients (%)	Prolonged Stay (%)	p^a
Age (years)	< 50	24 (25.8)	2 (8.5)	
	50.1–54	23 (24.7)	3 (13)	
	54.1–58	24 (25.8)	6 (25)	
	> 58	22 (23.6)	13 (59)	0.03
Sex	Male	68 (69.9)	17 (25)	0.43
	Female	25 (30.1)	7 (28)	
Obesity	Yes	24 (39.8)	7 (29.1)	0.30
	No	69 (40.2)	17 (24.6)	
Smoking	Yes	61 (64.5)	17 (27.9)	0.85
	No	32 (35.5)	7 (21.9)	
Diabetes	Yes	52 (53.8)	18 (34.6)	0.09
	No	41 (46.2)	6 (14.6)	
Albumin disorder	Yes	74 (69.9)	18 (24.3)	0.84
	No	21 (30.1)	6 (28.6)	
Chronic renal failure	Yes	37 (37.6)	10 (27)	0.38
	No	56 (62.4)	14 (25)	
Ejection fraction (%)	< 40	12 (24.5)	2 (16.7)	0.14
	> 40	81 (65.5)	22 (27.2)	
Operative time (h)	< 4	55 (54.8)	11 (20)	
	4–6	36 (35.5)	12 (33.3)	
	> 6	2 (9.7)	1 (50)	0.004
Procedure	CABG	49 (45.2)	10 (20.4)	0.37
	VR	29 (33.3)	9 (31)	
	Ao. Diss.	5 (7.5)	1 (20)	
	Reoperation	6 (7.5)	4 (66.7)	
	Transplant	2 (4.3)	0	
	Other	2 (2.1)	0	
Type of CABG	No	44 (47.3)	14 (31.8)	0.65
	Only vein	17 (18.3)	6 (35.3)	
	Left IMA+vein	27 (21.5)	4 (14.8)	
	Left IMA+right IMA+vein	5 (5.4)	0	
Emergency surgery	Yes	14 (25.8)	5 (35.7)	0.66
	No	79 (74.2)	19 (24)	
Opened pleural space	Yes	45 (48.4)	15 (33.3)	0.40
	No	48 (51.6)	9 (19.7)	
Cross-clamp time (min)	< 40	23 (21.5)	4 (17.3)	0.62
	40–60	52 (49.5)	15 (28.8)	
	> 60	18 (29)	5 (27.8)	
IABP	Yes	5 (17.2)	2 (40)	0.74
	No	88 (82.8)	22 (25)	
Length of intubation	< 24h	15 (29)	6 (40)	0.84
	> 24h	78 (71)	18 (23.1)	
Length of stay in ICU	< 48h	2 (6.4)	0	0.004
	48–96h	80 (68.8)	20 (25)	
	> 96h	11 (22.6)	4 (36.4)	
Bleeding (mL)	< 600	39 (36.6)	6 (15.4)	0.16
	600–1,000	52 (50.5)	16 (30.8)	
	> 1,000	2 (12.9)	2 (100)	
Transfusion	Yes	49 (52.7)	11 (22.4)	0.40
	No	44 (47.3)	13 (29.5)	
Reoperation for bleeding	Yes	23 (9.7)	1 (4.5)	0.52
	No	71 (90.3)	23 (32.4)	
Interval symptoms–WD (days)	< 20	89 (53.8)	20 (22.5)	
	> 20	4 (46.2)	4 (100)	0.001

Table 5. Variables Studied as Univariate Predictors of Prolonged Hospital Stay in Surviving Patients (Continued)

Variable	Categories	No. of Patients (%)	Prolonged Stay (%)	p^a
Positive bacteriologic data	Yes	38 (40.9)	7 (18.4)	0.17
	No	55 (59.1)	17 (30.9)	
Microbiologic data	Negative	54 (58)	17 (31.5)	0.09
	Gram+	29 (31.2)	6 (20.7)	
	Gram−	9 (9.7)	1 (11.1)	
	G+ and G−	1 (1.1)	0	
Staphylococcus aureus	Yes	16 (27.9)	2 (12.5)	0.09
	No	77 (72.1)	22 (28.6)	
Pseudomonas aeruginosa	Yes	7 (12.9)	1 (14.3)	0.52
	No	86 (87.1)	23 (26.7)	
Fever	yes	30 (43)	8 (26.7)	0.23
	No	63 (57)	16 (25.4)	
Leukocytosis	Yes	49 (54.8)	8 (16.3)	0.009
	No	44 (45.2)	16 (36.4)	

[a] Significant at $P < 0.05$. See Table 3 for abbreviations.

only patients with DSWI were included in our series, and those with sterile sternal instability were not considered in this study.

Our study shows that although demographic variables or those related to associated diseases such as diabetes and renal and hepatic insufficiency are risk factors in determining DSWI, they are not significant predictors of hospital death and prolonged hospitalization. It is surprising to note that although bilateral mammary artery harvesting in CABG procedures is associated with a significantly higher incidence of postcardiotomy DSWI in diabetic patients [1–8], it was not found to affect the outcome of the infection in our series.

The most significant variables predicting a bad outcome after DSWI were those related to postoperative management. Appropriate postoperative management can heavily influence DSWI prognosis. In our study the time between the onset of symptoms and wound debridement has been one of the most important factors affecting DSWI prognosis. Delay in reoperation allows time for the infection to spread deeply into the chest cavity causing sepsis, involvement of cardiac sutures, and sternal osteomyelitis. Moreover persistence of fever and leukocytosis after wound debridement adversely affects DSWI prognosis. It is obvious that such conditions are signs of inappropriate wound debridement and this should lead to a policy of timely surgical reexploration and accurate wound debridement.

Table 6. Multiple Logistic Regression Model: Variables Predicting Prolonged Hospital Stay

Variable	Goodness of Fit	Adjusted Odds Ratio	p Value
Operative time > 6 hours	0.976	7.232	0.001
Interval symptoms–WD > 20 days	1.235	4.267	0.001

WD = wound debridement.

Postoperative bleeding has been associated with significantly higher mortality in patients with DSWI. Although reoperation for bleeding does not influence DSWI prognosis, an amount of postoperative bleeding more than 1,000 mL/24 hours has been a strong determinant for DSWI outcome. Such results support evidence that timely surgical reexploration for bleeding may improve the prognosis of patients with DSWI. On the other hand, delay in surgical hemostasis can lead to retrosternal blood collection and consequent need for blood transfusion. Such conditions provide optimal local conditions for bacterial growth together with systemic immunodepression [25], thus worsening the prognosis of the infection.

Length of postoperative intubation and stay in intensive care are predictors of bad outcome after DSWI. Although such conditions are generally associated with poor preoperative cardiac function and severely disabling cardiac disease, they also allow postoperative wound contamination from the upper airways and secondary immunodepression caused by aggressive antibiotic therapy. Therefore fast-track protocols may improve DSWI prognosis.

In conclusion, risk factors for the development of complications of postoperative mediastinitis are mostly not modifiable. Furthermore, widening of indications for cardiac surgery will increase the number of patients with multiple risk factors. Nevertheless, our study shows that the prognosis of DSWI can be influenced by adequacy and quickness of treatment. Demographic variables and associated diseases do not affect DSWI prognosis, whereas prompt surgical reexploration for bleeding and early and proper wound debridement may significantly reduce mortality and morbidity after DSWI.

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